Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Issuance of ESA Section 10(a)(1)(A) Scientific Research and Enhancement Permit 22270-2R

NMFS Consultation Number: WCRO-2023-00172
NMFS Record Number: 151422WCR2023AR00048
Action Agency: National Marine Fisheries Service

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Southern Oregon/North California Coast (SONCC) coho salmon	Threatened	Yes	No	Yes	No
California Coastal (CC) Chinook Salmon	Threatened	Yes	No	Yes	No
Northern California (NC) steelhead	Threatened	Yes	No	Yes	No

Essential Fish Habitat and NMFS Determinations:

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	No

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

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Date: March 3, 2023

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1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3, below.

1.1. Background

NOAA's National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), as amended, and implementing regulations at 50 CFR part 402.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the Arcata, California NMFS office.

1.2. Consultation History

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

On December 15, 2022, NMFS received an application from the Wiyot Tribe (Applicant) in Loleta, California for modification and renewal of an ESA Section 10(a)(1)(A) Scientific Research and Enhancement permit (Permit 22270-2R). Although the proposed activities are for the purpose of enhancing the conservation of threatened Southern Oregon/North California Coast (SONCC) coho salmon, California Coastal (CC) Chinook salmon, and Northern California (NC) steelhead, the activities would nonetheless result in take of the species. Accordingly, NMFS prepared this biological opinion to assess the effects of authorizing the requested type and amount of take for these species. This biological opinion is based on the best scientific and commercial data available, including the description of the enhancement activities, a knowledge of and experience in the watershed and streams where the enhancement activities will be conducted, and expected effects of the activities.

1.3. Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (see 50 CFR 402.02).

Under MSA, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (see 50 CFR 600.910).

The proposed federal action involves NMFS issuing a 5-year ESA section 10(a)(1)(A) scientific research and enhancement permit (Permit 22270-2R) to the Applicant. The Applicant has requested non-lethal take of juvenile coho salmon and Chinook salmon, and non-lethal take of juvenile and adult steelhead. The University of California at Berkeley, Stillwater Sciences and California Trout are co-investigators on the permit and will assist with implementation of the permit activities.

1.3.1. Summary

Permit 22270-2R involves four primary elements: (1) removing large numbers of predatory non-native Sacramento pikeminnow using a variety of techniques in the South Fork Eel River, Van Duzen River, and Lower Eel River to enhance and increase the survival of listed salmonids and native species; (2) refining methods and strategies for pikeminnow suppression across a range of habitats; (3) operating a resistance board weir to segregate pikeminnow from the South Fork Eel River headwaters and further suppress their population; and (4) evaluate pikeminnow and salmonid responses to suppression activities. A brief summary of the field activities and requested type and amount of take follows.

Suppression techniques will include boat electrofishing, seining, active gillnetting, spearfishing, hook-and-line, and the weir trap box. Suppression timing, gear types, and methods are designed to minimize encountering and impacting salmonids. Importantly, prior to conducting suppression, sites will be snorkeled and will be avoided if salmonids are present. The weir will be operated after April 1, by which time most steelhead will have spawned and emigrated. A small proportion of adult steelhead will move through the weir.

To investigate how pikeminnow suppression influences their movement and survival, juvenile coho salmon, Chinook salmon and steelhead will be captured with downstream migrant traps, and a portion of juvenile coho salmon and juvenile steelhead will be acoustically-tagged, released, and tracked with a network of receivers. Field activities for the various proposed research and enhancement components will occur annually as described for each location below for a duration of approximately 5 years through December 31, 2028.

1.3.2. Resistance Board Weir

The seasonal resistance board weir will be constructed in the mainstem South Fork Eel River just downstream from Indian Creek, 83 river kilometers upstream from the mainstem Eel River (see Figure 1). For details on the specifics of the weir design, operation, and measures to reduce impacts on native fish see the supplemental Weir Operations Plan (Wiyot 2022). The primary goals of this method are to: (1) segregate migratory pikeminnow from prime salmon rearing habitat in the upper mainstem South Fork Eel River; (2) capture and euthanize large numbers of these introduced predatory fish and (3) better understand the life history timing of pikeminnow and native salmonids.

Figure 1: Proposed location of the resistance board weir (RBW), just downstream of Indian Creek on the South Fork Eel River in Mendocino County, California.

1.3.3. Other Suppression Techniques

Suppression techniques will include boat electrofishing, seining, active gillnetting, spearfishing, hook-and-line, and the resistance board weir (discussed above). Boat electrofishing will only be conducted in the lower reaches of the South Fork Eel River that do not contain salmonids during the summer sampling period. Prior to electrofishing, each sample site will be snorkeled to determine where pikeminnow are and to verify that no salmonids are present.

Seining will be conducted in the South Fork Eel River, Van Duzen River, and Lower Eel River using knotless nylon nets. In addition to sampling smaller size classes of pikeminnow in shallow water, seines may be deployed for active sampling, where snorkelers herd fish out of deeper water into the nets. Seines will also be used to capture juvenile coho salmon and steelhead for acoustic tagging.

Active gillnetting will be conducted in the mainstems of the South Fork Eel River, Van Duzen River, and Lower Eel River during time periods to avoid salmonids. As with other methods, prior to conducting gillnetting, each site will be snorkeled to ensure the absence of non-target species.

Gillnets will never be left unattended in the water; gillnets will be actively tended and constantly inspected to ensure no harm is done to salmonids or other non-target species. At some sites, two gillnets will may be actively maneuvered toward each other by divers to capture fleeing pikeminnow.

Spearfishing and hook and line sampling will be conducted in the South Fork Eel River, Van Duzen River, and Lower Eel River. Only divers with extensive experience distinguishing pikeminnow from native fish will be used. Hook-and-line sampling will rely on using only barbless hooks and any juvenile steelhead or other non-target species captured will be released immediately.

1.3.4. Research and Monitoring

Down-stream migrant trapping via fyke net will occur in selected tributaries of the upper South Fork Eel River, including the South Fork Eel headwaters (above Rattlesnake Creek), Elder Creek, Indian Creek, Sproul Creek, Cedar Creek, Hollow Tree Creek, and Tenmile Creek. The objective of trapping is to collect fish for acoustic tagging to evaluate survival and transit time in reaches above the weir (treated) and below the weir (not treated). Trapping will occur between late February and early May, depending on flows. The trap will be configured as either a pipe trap (during low flow), a fyke net (moderate flows) or a floating incline plane trap (during high flow up to 50 cfs). Backpack electrofishing may be used in select tributaries (not mainstem sites) to capture salmonids for tagging between April and July. Backpack electrofishing will be conducted using a Smith-Root backpack electrofisher. A minimum crew of at least three people will be deployed and will adhere to the NMFS (2000) guidelines for electrofishing salmonids.

1.3.5. Tissue Sampling and Acoustic Tagging

Tissue samples will be collected annually from up to 400 juvenile SONCC coho salmon, 400 juvenile NC steelhead, and 220 adult NC steelhead (including half-pounders). Small caudal fin clips will be collected using sterilized scissors on fish species with a fork length greater than 70 mm. In addition, a subset of juvenile coho salmon (up to 100) and steelhead (up to 100) assigned for tissue sampling will receive muscle biopsies rather than fin clips. To conduct the muscle biopsies, fish will be anesthetized and a small muscle plug will be removed. These samples will be spread-out among sampling events and locations to minimize impact on these species.

A subset of the juvenile salmonids captured which are > 80mm fork length will be anesthetized for surgery and implanted with SS400 Acoustic Transmitter (Injectable) acoustic transmitters. The SS400 weigh 216 mg, and are 15.00 mm long by x 3.38 mm wide. Tag to body weight ratio will not exceed 3.5% of those fish selected for acoustic tagging. Networks of acoustic arrays will track juvenile salmonid movement upstream and downstream of the resistance board weir.

1.3.6. Proposed Activities in the South Fork Eel River

The following activities in the South Fork Eel River and tributaries (between Little Rock Creek to the confluence with the mainstem Eel River; 100 miles) are permitted to be implemented annually during the timeframes specified below:

- Feb 1 – Jun 1: Daily for up to 2 weeks – fyke net trapping, seining;
- April 1 – October 1: Opportunistically – seining, electrofishing;
- April 1 – October 31: Daily – resistance board weir; Biweekly – spearfishing, seining;
- April 1 – September 30: Biweekly – active gillnetting, hook-and-line, snorkeling;
- July 1 – September 30: Weekly – boat electrofishing;
- June 15 – August 31: Biweekly – spearfishing, seining, active gillnetting, hook-and-line, snorkeling.

The annual sum of take being authorized across the various components of this effort in the South Fork Eel River and tributaries are presented in Table 1.

Table 1: Authorized annual take levels by species, life stage, action, method, and procedures for activities in the South Fork Eel River and tributaries (between Little Rock Creek to the confluence with the mainstem Eel River; 100 miles).

ESU/DPS Species	Life Stage	Authorized Take	Unintentional Mortality	Action	Method	Procedures
NC steelhead	Juvenile	1	1	Capture/Handle/ Release	Boat Electrofishing	
NC steelhead	Juvenile	5	1	Capture/Handle/ Release	Seine	
NC steelhead	Juvenile	5	1	Capture/Handle/ Release	Hook and line/angler/rod and reel	
NC steelhead	Juvenile	30	0	Observe/Harass	Snorkel/Dive surveys	
NC steelhead	Juvenile	5	1	Capture/Handle/ Release	Gillnet	
NC steelhead	Juvenile	300	6	Capture/Mark, Tag, Sample Tissue/Release	Backpack Electrofishing; fyke; seine	Tag, Acoustic or Sonic (Internal); Tissue Sample Fin or Opercle
SONCC coho salmon	Juvenile	300	6	Capture/Mark, Tag, Sample Tissue/Release	Backpack Electrofishing; fyke; seine	Tag, Acoustic or Sonic (Internal); Tissue Sample Fin or Opercle
NC steelhead	Adult	220	1	Capture/Mark, Tag, Sample Tissue/Release	Weir	Tissue Sample Fin or Opercle
NC steelhead	Adult	400	0	Observe/Harass	Camera/Video /Sonar	

ESU/DPS Species	Life Stage	Authorized Take	Unintentional Mortality	Action	Method	Procedures
NC steelhead	Juvenile	100	2	Capture/Mark, Tag, Sample Tissue/Release	Backpack Electrofishing; fyke; seine	Tag, Acoustic or Sonic (Internal); Tissue sample (other internal tissues); Tissue Sample Fin
SONCC coho salmon	Juvenile	100	2	Capture/Mark, Tag, Sample Tissue/Release	Backpack Electrofishing; fyke; seine	Tag, Acoustic or Sonic (Internal); Tissue sample (other internal tissues); Tissue Sample Fin
NC steelhead	Juvenile	1000	4	Capture/Handle/ Release	Backpack Electrofishing; fyke; seine	
SONCC coho salmon	Juvenile	1000	4	Capture/Handle/ Release	Backpack Electrofishing; fyke; seine	
CC Chinook salmon	Juvenile	1000	4	Capture/Handle/ Release	Backpack Electrofishing; fyke; seine	

1.3.7. Proposed Activities in the Van Duzen River

The following activities in the Van Duzen River from the confluence of the Eel River upstream to Salmon Falls are permitted to be implemented annually during the timeframes specified below:

- July 1 – October 31: Biweekly – spearfishing, seining, active gillnetting, hook-and-line, and snorkeling.

The annual sum of take being authorized across the various components of this effort in the Van Duzen River are presented in Table 2).

Table 2: Authorized annual take levels by species, life stage, action, and method for activities in the Van Duzen River from the confluence of the Eel River upstream to Salmon Falls.

ESU/DPS Species	Life Stage	Authorized Take	Unintentional Mortality	Action	Method
NC steelhead	Juvenile	25	1	Capture/Handle/Release	Seine
NC steelhead	Juvenile	5	1	Capture/Handle/Release	Gillnet
NC steelhead	Juvenile	5	1	Capture/Handle/Release	Hook and line/angler/rod and reel
NC steelhead	Juvenile	750	0	Observe/Harass	Snorkel/Dive surveys

1.3.8. Proposed Activities in the Lower Eel River

The following activities in the Lower Eel River (Mainstem Eel River: Fernbridge to the confluence with South Fork Eel River) are permitted to be implemented annually during the timeframes specified below:

- June 15 – August 31: Biweekly – spearfishing, seining, active gillnetting, hook-and-line, snorkeling.

The annual sum of take being authorized across the various components of this effort in the Lower Eel River are presented in Table 3.

Table 3: Authorized annual take levels by species, life stage, action, and method for activities in the Lower Eel River (Mainstem Eel River: Fernbridge to the confluence with the South Fork Eel River).

ESU/DPS Species	Life Stage	Authorized Take	Unintentional Mortality	Action	Method
NC steelhead	Juvenile	25	1	Capture/Handle/Release	Seine
NC steelhead	Juvenile	5	1	Capture/Handle/Release	Gillnet
NC steelhead	Juvenile	5	1	Capture/Handle/Release	Hook and line/angler/rod and reel
NC steelhead	Juvenile	750	0	Observe/Harass	Snorkel/Dive surveys
SONCC coho salmon	Juvenile	1	1	Capture/Handle/Release	Seine
SONCC coho salmon	Juvenile	1	1	Capture/Handle/Release	Gillnet

ESU/DPS Species	Life Stage	Authorized Take	Unintentional Mortality	Action	Method
SONCC coho salmon	Juvenile	1	1	Capture/Handle/Release	Hook and line/angler/rod and reel
SONCC coho salmon	Juvenile	100	0	Observe/Harass	Snorkel/Dive surveys
CC Chinook salmon	Juvenile	1	1	Capture/Handle/Release	Seine
CC Chinook salmon	Juvenile	1	1	Capture/Handle/Release	Gillnet
CC Chinook salmon	Juvenile	1	1	Capture/Handle/Release	Hook and line/angler/rod and reel
CC Chinook salmon	Juvenile	750	0	Observe/Harass	Snorkel/Dive surveys

We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would not.

2. Endangered Species Act: Biological Opinion And Incidental Take Statement

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species or to adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS, and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

NMFS determined the proposed action is likely to adversely affect SONCC coho salmon, CC Chinook salmon, NC steelhead, and their designated critical habitats.

2.1. Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50

CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion also relies on the regulatory definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designations of critical habitat use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this opinion, we use the terms "effects" and "consequences" interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their critical habitat using an exposure–response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species; or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" for the jeopardy analysis. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

2.2.1. Species Description and General Life History

2.2.1.1 SONCC Coho Salmon

Coho salmon have a generally simple 3-year life history. The adults typically migrate from the ocean and into bays and estuaries towards their freshwater spawning grounds in late summer and fall, and spawn by mid-winter. Adults die after spawning. The eggs are buried in nests, called redds, in the rivers and streams where the adults spawn. The eggs incubate in the gravel until fish hatch and emerge from the gravel the following spring as fry. These 0+ age fish typically rear in freshwater for about 15 months before migrating to the ocean. The juveniles go through a physiological change during the transition from fresh to salt water called smoltification. Coho salmon smolts typically outmigrate between March and July (Ricker et al. 2014). Coho salmon typically rear in the ocean for two growing seasons, returning to their natal streams as three-year-old fish to renew the cycle.

2.2.1.2 CC Chinook Salmon

CC Chinook salmon are typically fall spawners, returning to bays and estuaries before entering their natal streams in the early fall. The adults tend to spawn in the mainstem or larger tributaries of rivers. As with the other anadromous salmon, the eggs are deposited in redds for incubation. When the 0+ age fish emerge from the gravel in the spring, they typically migrate to saltwater shortly after emergence. Therefore, Chinook salmon typically enter the estuary as smaller fish compared to coho salmon. Chinook salmon are typically present in the stream-estuary ecotone, which is located in the downstream portions of major tributaries to estuaries like Humboldt Bay, from early May to early September, with peak abundance in June/July (Wallace and Allen 2007). Similar to coho salmon, prey resources during out-migration are critical to Chinook salmon survival as they grow and move out to the open ocean. A study by MacFarlane (2010) indicated that juvenile Chinook salmon require less prey in the estuary, equivalent to one northern anchovy (*Engraulis mordax*) per day, compared to a range of one to four anchovies needed per day in the ocean.

2.2.1.3 NC Steelhead

Steelhead are the anadromous form of *O. mykiss*, spending time in both fresh and saltwater. Steelhead generally return to freshwater to spawn as 4 or 5-year-old adults. Unlike other Pacific salmonids, steelhead can survive spawning and return to the ocean only to return to spawn in a future year. It is rare for steelhead to survive more than two spawning cycles. Steelhead typically spawn between December and May. Like other Pacific salmonids, the steelhead female deposits her eggs in a redd for incubation. The 0+ age fish emerge from the gravel to begin their freshwater life stage and can rear in their natal stream for 1 to 4 years before migrating to the ocean.

Steelhead have a similar life history as noted above for coho salmon, in the sense that they rear in freshwater for an extended period before migrating to saltwater. As such, they enter the estuary as larger fish (mean size of about 170 to 180 mm or 6.5 to 7.0 inches) and are, therefore, more oriented to deeper water channels. The California Department of Fish and Wildlife (CDFW) data indicate that steelhead smolts generally migrate downstream toward the estuary between March 1 and July 1 each year, although they have been observed as late as September (Ricker et al. 2014). The peak of the outmigration timing varies from year to year within this range, and generally falls between early April and mid-May.

2.2.2. Status of Species and Critical Habitat

In this biological opinion, NMFS assesses four population viability parameters to help us understand the status of each species and their ability to survive and recover. These population viability parameters are: abundance, population productivity, spatial structure, and diversity (McElhaney et al. 2000). While there is insufficient information to evaluate these population viability parameters in a thorough quantitative sense, NMFS has used existing information, including the Recovery Plan for SONCC Coho Salmon (NMFS 2014) and Coastal Multispecies Recovery Plan (NMFS 2016), to determine the general condition of each population and factors responsible for the current status of the ESU and DPS. We use these population viability parameters as surrogates for numbers, reproduction, and distribution, the criteria found within the regulatory definition of jeopardy (50 CFR 402.02).

2.2.2.1 Status of SONCC Coho Salmon

SONCC Coho Salmon Abundance and Productivity: Although long-term data on coho salmon abundance are scarce, the available evidence from short-term research and monitoring efforts indicate that spawner abundance has declined since the last status review for populations in this ESU (Williams et al. 2016). In fact, 24 of the 31 independent populations in the ESU are at high risk of extinction because they are below or likely below their depensation threshold, which can be thought of as the minimum number of adults needed for survival of a population. No populations are at a low risk of extinction and all core populations are thousands short of the numbers needed for recovery (Williams et al. 2016).

SONCC Coho Salmon Spatial Structure and Diversity: The distribution of SONCC coho salmon within the ESU is reduced and fragmented, as evidenced by an increasing number of previously occupied streams from which SONCC coho salmon are now absent (NMFS 2001, Good et al. 2005, Williams et al. 2011, Williams et al. 2016). Extant populations can still be found in all major river basins within the ESU (70 FR 37160; June 28, 2005). However, extirpations, loss of brood years, and sharp declines in abundance (in some cases to zero) of SONCC coho salmon in several streams throughout the ESU indicate that the SONCC coho salmon's spatial structure is more fragmented at the population-level than at the ESU scale. The genetic and life history diversity of populations of SONCC coho salmon is likely very low. The SONCC coho salmon ESU is currently considered likely to become endangered within the foreseeable future in all or a significant portion of its range, and there is heightened risk to the persistence of the ESU as Viable Salmonid Population parameters continue to decline and no improvements have been noted since the previous status review (Williams et al. 2016).

2.2.2.2 Status of CC Chinook Salmon

CC Chinook Salmon Abundance and Productivity: Low abundance, generally negative trends in abundance, reduced distribution, and profound uncertainty as to risk related to the relative lack of population monitoring in California have contributed to NMFS' conclusion that CC Chinook salmon are likely to become an endangered species within the foreseeable future throughout all or a significant portion of their range. Where monitoring has occurred, Good et al. (2005) found that historical and current information indicates that CC Chinook salmon populations are depressed. Uncertainty about abundance and natural productivity, and reduced distribution are among the risks facing this ESU. Concerns regarding the lack of population-level estimates of abundance, the loss of populations from one diversity stratum[1] as well as poor ocean survival contributed to the conclusion that CC Chinook salmon are likely to become an endangered species in the foreseeable future (Good et al. 2005, Williams et al. 2011, Williams et al. 2016).

CC Chinook Salmon Spatial Structure and Diversity: Williams et al. (2011) found that the loss of representation from one diversity stratum, the loss of the spring-run history type in two diversity substrata, and the diminished connectivity between populations in the northern and southern half of the ESU pose a concern regarding viability for this ESU. Based on consideration of this updated information, Williams et al. (2016) concluded the extinction risk of the CC Chinook salmon ESU has not changed since the last status review. The genetic and life history diversity of populations of CC Chinook salmon is likely very low and is inadequate to contribute to a viable ESU, given the significant reductions in abundance and distribution.

2.2.2.3 Status of NC Steelhead

NC Steelhead Spatial Structure and Diversity: NC steelhead remain broadly distributed throughout their range, with the exception of habitat upstream of dams on both the Mad River and Eel River, which has reduced the extent of available habitat. Extant summer-run steelhead populations exist in Redwood Creek and the Mad, Eel (Middle Fork, Van Duzen), and Mattole rivers. The abundance of summer-run steelhead was considered "very low" in 1996 (Good et al. 2005), indicating that an important component of life history diversity in this DPS is at risk. Hatchery practices in this DPS have exposed the wild population to genetic introgression and the potential for deleterious interactions between native stock and introduced steelhead. However, abundance and productivity in this DPS are of most concern, relative to NC steelhead spatial structure and diversity (Williams et al. 2011).

NC Steelhead Abundance and Productivity: With few exceptions, NC steelhead are present wherever streams are accessible to anadromous fish and have sufficient flows. The most recent status review by Williams et al. (2016) reports that available information for winter-run and summer-run populations of NC steelhead do not suggest an appreciable increase or decrease in extinction risk since publication of the last viability assessment (Williams et al. 2011). Williams et al. (2016) found that population abundance was very low relative to historical estimates, and recent trends are downwards in most stocks.

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[1] A diversity stratum is a grouping of populations that share similar genetic features and live in similar ecological conditions.

2.2.2.4 Status of Critical Habitats

The condition of SONCC coho salmon, CC Chinook salmon, and NC steelhead critical habitat, specifically its ability to provide for conservation, has been degraded from conditions known to support viable salmonid populations. NMFS has determined that currently depressed population conditions are, in part, the result of the following human induced factors affecting critical habitat: timber harvest, agriculture, mining, urbanization, stream channelization, dams, wetland loss, and water withdrawals (including unscreened diversions for irrigation). Impacts of concern include altered stream bank and channel morphology, non-native predators, elevated water temperature, lost spawning and rearing habitat, habitat fragmentation, impaired gravel and wood recruitment from upstream sources, degraded water quality, lost riparian vegetation, and increased erosion into streams from upland areas (Williams et al. 2016, Weitkamp et al. 1995). Diversion and storage of river and stream flow has dramatically altered the natural hydrologic cycle in many of the streams within the ESU/DPS. Altered flow regimes can delay or preclude migration, dewater aquatic habitat, and strand fish in disconnected pools, while unscreened diversions can entrain juvenile fish.

Recent publications have identified a degradation product of tires (6PPD-quinone) as the causal factor of mortality for all life stages of salmonids at concentrations of less than a part per billion (Tian et al. 2022). This contaminant is widely used by multiple tire manufacturers and the tire dust and shreds that produce it have been found to be ubiquitous where both rural and urban roadways drain into waterways (Sutton et al. 2019).

2.2.3. Factors Responsible for the Decline of Species and Critical Habitat

The factors that caused declines of species and degradation of critical habitat include hatchery practices, ocean conditions, habitat loss due to dam building, degradation of freshwater habitats due to a variety of agricultural and forestry practices, water diversions, urbanization, over-fishing, mining, climate change, and severe flood events exacerbated by land use practices (Good et al. 2005, Williams et al. 2016). Sedimentation and loss of spawning gravels associated with poor forestry practices and road building are particularly chronic problems that can reduce the productivity of salmonid populations. Late 1980s and early 1990s droughts and unfavorable ocean conditions were identified as further likely causes of decreased abundance (Good et al. 2005). Since 2014, drought conditions in California reduced stream flows and increased temperatures, further exacerbating stress and disease. Drought conditions during present conditions in 2021 represent near record low conditions in both precipitation and streamflow. Ocean conditions have been unfavorable in past years due to the El Niño in 2015 and 2016 and other anomalously warm waters in the Gulf of Alaska. Reduced flows can cause increases in water temperature, resulting in increased heat stress to fish and thermal barriers to migration.

Another factor affecting the range wide status of SONCC coho salmon, CC Chinook salmon and NC steelhead, and aquatic habitat at large is climate change. Recent work by the NMFS Science Centers ranked the relative vulnerability of west-coast salmon and steelhead to climate change. In California, listed coho and Chinook salmon are generally at greater risk (high to very high risk) than listed steelhead (moderate to high risk) (Crozier et al 2019).

Impacts from global climate change are already occurring in California. For example, average annual air temperatures, heat extremes, and sea level increased in California over the last century (Kadir et al. 2013). Snowmelt from the Sierra Nevada has declined (Kadir et al. 2013). Although SONCC coho salmon, CC Chinook salmon and NC steelhead are not dependent on snowmelt driven streams, they have likely already experienced some detrimental impacts from climate change through lower and more variable stream flows, warmer stream temperatures, and changes in ocean conditions. California experienced well below average precipitation during the 2012-2016 drought, as well as record high surface air temperatures in 2014 and 2015, and record low snowpack in 2015 (Williams et al. 2016). Paleoclimate reconstructions suggest the 2012-2016 drought was the most extreme in the past 500 to 1000 years (Williams et al. 2016, Williams et al. 2020, Williams et al. 2022). Anomalously high surface temperatures substantially amplified annual water deficits during 2012-2016. California entered another period of drought in 2020. These drought periods are now likely part of a larger drought event (Williams et al. 2022). This recent long-term drought, as well as the increased incidence and magnitude of wildfires in California, have likely been exacerbated by climate change (Williams et al. 2020, Williams et al. 2022, Diffenbaugh et al. 2015, Williams et al. 2019).

The threat to SONCC coho salmon, CC Chinook salmon and NC steelhead from global climate change is expected to increase in the future. Modeling of climate change impacts in California suggests that average summer air temperatures are expected to continue to increase (Lindley et al. 2007, Moser et al. 2012). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe et al. 2004; Moser et al. 2012, Kadir et al. 2013). Total precipitation in California may decline and the magnitude and frequency of dry years may increase (Lindley et al. 2007, Schneider 2007, Moser et al. 2012). Similarly, wildfires are expected to increase in frequency and magnitude (Westerling et al. 2011, Moser et al. 2012). Increases in wide year-to- year variation in precipitation amounts (droughts and floods) are projected to occur (Swain et al. 2018). Estuarine productivity is likely to change based on changes in freshwater flows, nutrient cycling, and sediment amounts (Scavia et al. 2002, Ruggiero et al. 2010).

In marine environments, ecosystems and habitats important to juvenile and adult salmonids are likely to experience changes in temperatures, circulation, water chemistry, and food supplies (Brewer and Barry 2008, Feely 2004, Osgood 2008, Turley 2008, Abdul-Aziz et al. 2011, Doney et al. 2012). Some of these changes, including an increased incidence of marine heat waves, are likely already occurring, and are expected to increase (Frolicher, et al. 2018). In fall 2014, and again in 2019, a marine heatwave, known as "The Blob"[2], formed throughout the northeast Pacific Ocean, which greatly affected water temperature and upwelling from the Bering Sea off Alaska, south to the coastline of Mexico. The marine waters in this region of the ocean are utilized by salmonids for foraging as they mature (Beamish 2018). Although the implications of these events on salmonid populations are not fully understood, they are having considerable adverse consequences to the productivity of these ecosystems and presumably contributing to poor marine survival of salmonids.

Overall, climate change is believed to represent a growing threat, and will challenge the resilience of SONCC coho salmon, CC Chinook salmon, and NC steelhead.

[2] https://www.fisheries.noaa.gov/feature-story/new-marine-heatwave-emerges-west-coast-resembles-blob

2.3. Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area includes the South Fork Eel River and tributaries; the Van Duzen River from its confluence with the Eel River and upstream to Salmon Falls (located near Dinsmore, California); and the Lower Eel River from Fernbridge, California, and upstream to the confluence with the South Fork Eel River.

2.4. Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

In the action area, the threat to SONCC coho salmon, CC Chinook salmon, and NC steelhead from climate change is likely to include a continued increase in average summer air temperatures; more extreme heat waves; and an increased frequency of drought (Lindley et al. 2007). In future years and decades, many of these changes are likely to further degrade habitat throughout the watershed by, for example, reducing streamflow during the summer and raising summer water temperatures. Many of these impacts will likely occur in the action area via higher water temperatures and reduced flows, which create habitat conditions which favor Sacramento pikeminnow.

SONCC coho salmon in the action area belong to the South Fork Eel River population (those individuals occurring in the South Fork Eel River and its tributaries) as well as the Lower Eel/Van Duzen River population (those individuals occurring in the Van Duzen and Lower Eel Rivers). The NMFS SONCC Coho Salmon Recovery Plan indicates the South Fork Eel River population is at moderate risk of extinction, while the Lower Eel/Van Duzen River population is at a high risk of extinction (NMFS 2014). Chinook salmon in the action area belong to the Lower Eel/South Fork population, which the NMFS Coastal Multispecies Recovery Plan suggests is likely well below the number needed to be at a low risk of extinction (NMFS 2016). Winter-run NC steelhead in the action area belong to the South Fork Eel River population (individuals in the South Fork and Lower Eel River) and Van Duzen River population (individuals in the Van Duzen or Lower Eel River, which are also likely well below the number needed to be at a low risk of extinction (NMFS 2016). The Coastal Multispecies Recovery Plan indicates a need for at least 250 adult summer-run steelhead to avoid the effects of depensation within the South Fork Eel and Van Duzen River populations of summer-run steelhead (NMFS 2016).

A recent estimate of the number of redds produced by pairs of spawning salmon and steelhead in the South Fork Eel River during 2013 indicate an estimated 879 SONCC coho salmon redds; 149 CC Chinook salmon redds; and 1,113 NC steelhead redds (Ricker et al. 2015). Summer-run steelhead have been documented in the Van Duzen River and Lower Eel River portions of the action area. It should be noted that both the Chinook and steelhead data likely represent underestimates given the timing and distribution of the survey effort being geared towards coho salmon.

2.4.1. Status of the Listed Species and Critical Habitat in the Action Area

The condition of designated critical habitats in the action area, specifically their ability to provide for conservation, is degraded from conditions known to support viable populations. The highest threats to SONCC coho salmon, CC Chinook salmon, and NC steelhead in the South Fork Eel River are water diversions and impoundments, largely due to the cannabis industry and rural land use (NMFS 2014, 2016). Reducing the abundance of Sacramento pikeminnow was considered one of the highest priorities for recovering SONCC coho salmon (NMFS 2014), and predation and competition was rated as a high threat to juvenile NC steelhead (NMFS 2016). The South Fork Eel River consistently remains in the stressful to lethal range for salmonids during the summer (Kubicek 1977, NMFS 2014), which favors Sacramento pikeminnow. The Van Duzen River and Lower Eel River portions of the action area have similar issues with high water temperatures; predation/competition from Sacramento pikeminnow; and channel modification.

2.4.2. Previous ESA Section 7 Consultations in the Action Area

NMFS' ESA Section 10(a)(1)(A) research and enhancement permits. and research projects in the annual CDFW ESA Section 4(d) Research Program could potentially occur in the action area. Salmonid monitoring approved under these programs includes carcass surveys, adult salmonid monitoring and juvenile surveys. The Community of Shively operates a temporary seasonal bridge over the lower Eel River, which NMFS' Biological Opinion (WCRO-2019-00115) anticipated small numbers of juveniles would be taken during the installation and removal of the seasonal bridge. The Humboldt Redwoods State Parks Watershed Restoration Program operates in the South Fork and Lower Eel Rivers, which NMFS' Biological Opinion (WCRO-2022-00629) anticipated small numbers of juveniles would be taken. The Humboldt County Gravel Mining Program occurs at several locations within the action area, an NMFS' Biological Opinion anticipated small numbers of juveniles would be taken. In general, these activities are closely monitored and require measures to minimize and monitor for take. NMFS determined these projects were unlikely to affect future adult returns.

2.5. Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action (see 50 CFR 402.02). A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered the factors set forth in 50 CFR 402.17(a) and (b).

2.5.1. Collection Methods

The primary effect of the proposed research and enhancement will be on the listed species in the form of capturing and handling the fish. Harassment caused by capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, let alone entire species. The following subsections describe the types of activities being proposed. The activities would be carried out by trained professionals using established protocols. The effects of the activities are well documented and discussed in detail below.

2.5.1.1 Observation

For some portions of the proposed studies, listed fish would be observed but not captured (e.g., by snorkel surveys or from the banks). Observation without handling is the least disruptive method for determining a species' presence/absence and estimating their relative numbers. Its effects are also generally the shortest-lived and least harmful of the research activities discussed in this section because a cautious observer can effectively obtain data while only slightly disrupting the fishes' behavior. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water or behind or under rocks or vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area. At times, the research involves observing adult fish, which are more sensitive to disturbance. Harassment is the primary form of take associated with these observation activities, and few if any injuries (and no deaths) are expected to occur. Because these effects are so small, there is little a researcher can do to mitigate them except to avoid disturbing sediments, gravels, and, to the extent possible, the fish themselves, and allow any disturbed fish the time they need to reach cover.

2.5.1.2 Electrofishing

Electrofishing is a process by which an electrical current is passed through water containing fish to stun them, which makes them easy to capture. High voltage current is passed between an anode and a cathode, which induces muscular convulsions (galvanotaxis) in fish when they encounter a high enough voltage gradient between the electrodes. Electrofishing can have several short-term effects, including stress, fatigue, reduced feeding, and susceptibility to predation (NMFS 2000). Electrofishing can also cause physical injuries such as internal hemorrhaging and spinal injuries, which are caused by galvanotaxis. Mortality from electrofishing is typically due to respiratory failure or asphyxiation (Snyder 2003). The extent to which sampled fish are affected depends on the electrofishing waveform, pulse frequency, fish age and size, number of exposures, and operator skill (Simpson et al. 2016). Research indicates that using continuous direct current (DC) or low-frequency (30 Hz) pulsed DC waveforms (PDC) produce lower spinal injury rates, particularly for salmonids (Holliman et al. 2010). Higher frequencies generally result in better catch efficiency albeit with higher rates of injury (Chiaramonte et al. 2020).

Adult salmonids are particularly susceptible to spinal injuries, as longer fish (> 300mm) are subjected to strong voltage gradients by the electrofishing anode (Pottier & Marchand 2020). Spinal injuries to salmonids become increasingly detectable over time and are often not immediately apparent (Holliman et al. 2010). To avoid causing such injuries, we do not allow electrofishing to be used as a method for capturing adult salmonids. Though electrofishing crews do sometimes inadvertently encounter adults during their work, they must immediately turn off their equipment and allow the fish to swim away. Smaller, juvenile fish are subjected to lesser voltage gradients, but there is conflicting evidence about whether this results in lower rates of injury (Snyder 2003). Spawning female salmonids are also vulnerable, since electrofishing can reduce survival rates for eggs spawned from previously electroshocked females (Cho et al. 2002, Huysman et al. 2018). Salmon in early developmental stages, including embryos and alevin, are another vulnerable group for whom electrofishing should be avoided (Simpson et al. 2016). Electrofishing can also inflict harm on non-target species, particularly during multiple pass depletion surveys, during which non-target fish can be exposed to multiple electroshocks (Panek & Densmore 2011).

When using appropriate electrofishing protocols and equipment settings, shocked fish normally revive quickly. When done carefully, electrofishing of individual fish has been shown to not affect wild salmonid abundance, and individual long-term survival is not usually compromised (Snyder 2003). However, individual growth may be stunted by electroshock exposure, resulting in abnormally low weight and small size (Dwyer et al. 2001). The latent, sublethal, and population level impacts of electrofishing are areas that are not well understood, and in which further research is recommended.

In larger streams and rivers, electrofishing units are sometimes mounted on boats or rafts. These units often use more current than backpack electrofishing equipment because they need to cover larger and deeper areas. The environmental conditions in larger, more turbid streams can limit researchers' ability to minimize impacts on fish. As a result, boat electrofishing can have a greater impact on fish. Researchers conducting boat electrofishing must follow NMFS' electrofishing guidelines. Research carried out under Permit 22270-2R that relies on boat electrofishing will only occur in areas where water temperatures preclude the possibility of SONCC coho salmon, CC Chinook, or NC steelhead being present. Additionally, areas that will be subject to boat electrofishing will be snorkeled first to ensure that no salmonids are present.

2.5.1.3 Hook and Line

Fish caught with hook and line and released alive may still die due to injuries and stress they experience during capture and handling. Angling-related mortality rates vary depending on the type of hook (barbed vs barbless), the type of bait (natural vs artificial), water temperature, anatomical hooking location, species, and the care with which fish are handled and released (level of air exposure and length of time for hook removal). Research carried out under Permit 22270-2R that relies on hook and line angling methods are intended to target non-native Sacramento pikeminnow. While pursuing Sacramento pikeminnow with hook and line methods, it is possible juvenile steelhead may be caught.

Juvenile steelhead occupy many waters that are also occupied by resident trout species and it is not possible to visually separate juvenile steelhead from similarly-sized, stream-resident, rainbow trout. Because juvenile steelhead and stream-resident rainbow trout are the same species, are similar in size, and have the same food habits and habitat preferences, it is reasonable to assume that catch-and-release mortality studies on stream-resident trout are similar for juvenile steelhead. Where angling for trout is permitted, catch-and-release fishing with prohibition of use of bait reduces juvenile steelhead mortality more than any other angling regulatory change.

Most studies have found a notable difference in the mortality of fish associated with using barbed versus barbless hooks (Huhn and Arlinghaus 2011). Researchers have generally concluded that barbless hooks result in less tissue damage, they are easier to remove, and because they are easier to remove the handling time is shorter. In summary, catch-and-release mortality of steelhead is generally lowest when researchers are restricted to use of artificial flies and lures.

Catch and release fishing does not seem to have an effect on migration. Lindsay et al. (2004) noted that "hooked fish were recaptured at various sites at about the same frequency as control fish". Bendock and Alexandersdottir (1993) found that most of their tagged fish later turned up on the spawning grounds. Cowen et al. (2007) found little evidence of an adverse effect on spawning success for Chinook salmon. Nonetheless, given the fact that no ESA section 10 permit or 4(d) authorization may "operate to the disadvantage of the species," we allow no more than a three percent mortality rate for any listed species collected via angling, and all such activities must employ barbless hooks.

2.5.1.4 Seine and Fyke Net Traps

Seines and fyke net traps are generally used to obtain information on fish distribution and abundance, habitat use, life history, and outmigration timing, and are often used to capture fish for further data collection procedures such as acoustic tagging, tissue sampling, or gastric lavage. Beach seines are used to collect juvenile fish in shallow-water habitats. Boat seines (such as purse seines) and large traps (such as fyke traps, or similar) are used in larger waterbodies or for capturing migrating animals. Nets can injure fish by removing protective mucus and tearing gills (Patterson et al. 2017). Wearing gloves during handling and using soft rubber or knotless nets minimizes damage to fish gills, scales, and mucus. Minimizing holding and processing time while emptying seines, traps, and nets can also reduce potential impacts (see Handling and Sedation, below). Based on years of sampling at hundreds of locations under hundreds of scientific research authorizations, we would expect the mortality rates for fish captured by seines, traps, or nets to be three percent or less.

2.5.1.5 Gillnet

Gillnets are suspended from the water's surface with floats and have weights along the bottom. Researchers must select the mesh size carefully depending on their target species. Fish may be injured or die if they become physiologically exhausted in the net or if they sustain injuries such as abrasion or fin damage. Entanglement in nets can damage the protective slime layer, making fish more susceptible to infections. These injuries can result in immediate or delayed mortality. Vander Haegen et al. (2005) emphasized that, to minimize both immediate and delayed mortality, researchers must employ best practices including using short nets with short soak times, and removing fish from the net carefully and promptly after capture. As with other types of capture, fish stress increases rapidly if the water temperature exceeds 18 ºC or dissolved oxygen is below saturation. Risks to salmonids will be minimized by snorkeling the area to ensure there are no salmonids present before setting gillnets, and by actively monitoring nets by divers underwater to rapidly untangle and release species other than Sacramento pikeminnow.

2.5.1.6 Resistance Board Weir

Capture of adult salmonids by weirs is common practice in order to collect information on adult salmon and steelhead, but is being applied in this case to segregate and remove non-native predatory Sacramento pikeminnow in order to enhance survival of native species. Weirs have the potential to delay migration whether or not individuals are actually captured and held in a live box. All weir projects adhere to the NMFS West Coast Region Weir Guidelines, which require the following: traps must be checked and emptied daily; all weirs including video and DIDSON sonar weirs must be inspected and cleaned of any debris daily; the development and implementation of monitoring plans to assess passage delay, and development and implementation of a weir operating plan. These guidelines are intended to help improve fish weir design and operation in ways which will limit fish passage delays and increase weir efficiency.

The weir will be installed after April 1 to avoid the peak of the adult steelhead spawning migration season. As many as 220 adult steelhead are expected to be captured and held in the weir's trap box, where they may be handled and subjected to tissue sampling. Of these fish, one adult NC steelhead is expected to die as the result of handling stress. Juveniles will be able to pass through either the downstream passage chute within the weir, or be able to navigate in between the pickets of the weir given the spacing of pickets on the weir is large so that only larger fish would be segregated by the weir.

2.5.2. Handling

The primary factors that contribute to stress and mortality from post-capture handling and processing of fish are excessive doses of anesthetic, differences in water temperature, dissolved oxygen conditions, the amount of time that fish are held out of water, and physical trauma. Harassment caused by capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, populations, and species. Handling of fish may cause stress, injury, or death, which typically are due to overdoses of anesthetic, differences in water temperatures between the river and holding buckets, depleted dissolved oxygen in holding buckets, holding fish out of the water, and physical trauma. Excessive air exposure causes gill lamellae to collapse, ceasing aerobic respiration and causing hypoxia. High water temperature can contribute to high mortality following air exposure (Patterson et al. 2017).

Loss of protective mucus is a common injury during capture and handling which increases susceptibility to disease (Cook et al. 2018). Mucus contains antibacterial proteins, and its loss makes fish vulnerable to pathogens that may cause infections and latent mortality. Fish held at higher water temperature have a higher risk of infection post-sampling (Patterson et al. 2017). Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Additionally, stress can occur if there are more than a few degrees difference in water temperature between the stream/river and the holding tank.

Exhaustion from excess physical activity can also result in death through acidosis or latent mortality due to the inability to recover from exhaustion. Fish that survive physiological imbalances caused during handling can lose equilibrium and have impaired swimming abilities, increasing their susceptibility to predation (Cook et al. 2018). Fish transferred to holding buckets can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, nets, and buckets. Capture and handling stressors can combine to cause cumulative effects that greatly increase the likelihood of fish mortality. The permit conditions contain measures that mitigate factors that commonly lead to stress and trauma from handling, and thus minimize the harmful effects of capturing and handling fish. When these measures are followed, fish typically recover rapidly from handling. Some fish are expected to be unintentionally killed during handling (see Tables 1, 2, and 3).

2.5.2.1 Acoustic/Radio Tags and Sedation

The method being used for implanting tags is to place them within the body cavities of juvenile salmonids. These tags do not interfere with feeding or movement. However, the tagging procedure is difficult, requiring considerable experience and care (Nielsen 1992) that requires the fish be sedated. Before surgery to implant acoustic tags, fish will be sedated by Tricaine Methanesulfonate (MS-222). MS-222 is a widely used anesthetic in fish research, and the only fish anesthetic approved by the FDA for use in fish that people may consume. During surgery an anesthetic maintenance dose is required to maintain stage 4 anesthesia (Carter et al. 2010). MS-222 can cause several side effects, including compromising a fish's antioxidant defenses, increasing cortisol (which reduces oxygen uptake), and reducing blood flow through the gills (Teles et al. 2019). Long-term effects of MS-222 exposure are not adequately known, and ease of accidental overdose from MS-222 is a concern (Carter et al. 2010).

Because the tag is placed within the body cavity, it is possible to injure a fish's internal organs. Fish with internal tags often die at higher rates than fish tagged by other means because tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance. As with the other forms of tagging and marking, researchers will keep the harm caused by tagging to a minimum by following the conditions in the permits as well as any other permit-specific requirements. Acoustic tags would be applied to only larger-sized smolts (over 80 millimeters) and there may be a two percent mortality rate for fish who receive acoustic tags and tissue samples (see Table 1).

2.5.2.2 Tissue Sampling

Tissue sampling techniques such as fin-clipping are common to many scientific research efforts using listed species. All sampling, handling, and clipping procedures have an inherent potential to stress, injure, or even kill the fish. This section discusses tissue sampling processes and its associated risks. As many as 300 juvenile SONCC coho salmon and 300 juvenile NC steelhead will receive fin clip tissue samples. As many as 100 juvenile SONCC coho salmon and 100 juvenile NC steelhead will receive muscle biopsies, where a small muscle plug will be collected posterior to the dorsal fin (see Table 1).

2.5.3. Critical Habitat

In general, most of the permitted activities would be (1) electrofishing, (2) capturing fish with angling equipment, traps, and nets of various types, (3) collecting biological samples from live fish, and (4) collecting fish for biological sampling. All of these techniques are minimally intrusive in terms of their effect on habitat because they would involve very little, if any, disturbance of streambeds or adjacent riparian zones. There will be alterations to the streambed and associated turbidity during the installation, removal, and operations of the seasonal resistance board weir in the South Fork Eel River. The weir will also cause a brief impediment to migration for a limited number of adult steelhead who become trapped in the weir's live box. NMFS expects the effects of suspended sediments and turbidity caused by researcher's foot traffic and resistance board weir to be minimal and temporary.

2.5.4. Cumulative Effects

"Cumulative effects" are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation [50 CFR 402.02 and 402.17(a)]. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described earlier in the discussion of environmental baseline (Section 2.4).

SONCC coho salmon, CC Chinook salmon, and NC steelhead in the action area are likely to be affected by future, ongoing non-federal activities like agriculture and timber harvest, both from upstream sources and within the action area. Water diversions also contribute to diminished stream flows and warmer water temperatures. The future effects of agriculture and timber harvest include continued land disturbance, road construction and maintenance, and higher rates of erosion and sedimentation.

2.6. Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

SONCC coho salmon, CC Chinook salmon, and NC steelhead have declined to a large degree from historic numbers and summer run populations of NC steelhead are in very poor condition. As described in the Effects of the Action section, a small number of juveniles may be injured or killed. NMFS does not expect that the loss of juveniles caused by research and enhancement activities would impact future adult returns for SONCC coho salmon, CC Chinook salmon, or NC steelhead. Permit activities will occur in only one discrete location at any time, and there will be large numbers of individuals residing in the action area who remain largely unaffected. The loss of one adult steelhead is also not expected to affect future adult returns, as the survival of offspring produced by other spawning adult NC steelhead will be enhanced by the removal and segregation of large numbers of predatory Sacramento pikeminnow. In NMFS' judgement, they are likely to produce enough future spawning adult fish to outweigh any losses from the action area. There will be adverse effects to critical habitat in the action area as migration is expected to be temporarily delayed by the resistance board weir. Overall, improvements to critical habitat via a reduction in predation and competition by removing large numbers of predatory Sacramento pikeminnow will ameliorate brief delays in migration caused at the resistance board weir.

The action area could be subject to higher average summer air temperatures and lower total precipitation levels due to climate change. Although the total precipitation levels may decrease, the average rainfall intensity has increased and is expected to continue to increase in the future. Higher air temperatures would likely warm stream temperatures. Reductions in the amount of precipitation would reduce stream flow levels and estuaries may also experience changes in productivity due to changes in freshwater flows, nutrient cycling, and sediment amounts. For this project, all of the activities would be completed by 2032 and the likely long-term effects of climate change described above are likely to continue to cause repeated severe droughts, increased air and water temperatures, and increased wildfire intensity. Because the permitted activities will enhance the survival of listed species throughout the action area, NMFS expects it will help improve the resilience of species and habitats to climate change over the long term. Overall, the project is unlikely to appreciably reduce the likelihood of survival and recovery of SONCC coho salmon, CC Chinook salmon, or NC steelhead, and the project is unlikely to appreciably diminish the value of designated critical habitat for the conservation of the species.

2.7. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of SONCC coho salmon, CC Chinook salmon, or NC steelhead, nor destroy or adversely modify their designated critical habitats.

2.8. Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Harass" is further defined by interim guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

In this instance, for the actions considered in this opinion, there is no incidental take at all. The reason for this is that all the take contemplated in this document would be carried out under permits that allow the permit holders to directly take the animals in question. Because the action would not cause any incidental take, we are not specifying an amount or extent of incidental take that would serve as a reinitiation trigger. Nonetheless, the amounts of direct take have been specified and analyzed in the effects section above. Those amounts constitute hard limits on both the amount and extent of take the permit holder would be allowed in a given year. Those amounts are also noted in the reinitiation clause just below because exceeding them would likely trigger the need to reinitiate consultation.

2.9. Reinitiation of Consultation

This concludes formal consultation for Permit 22270-2R. Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

In the context of this opinion, there is no incidental take anticipated and the reinitiation trigger set out in § 402.16(a)(1) is not applicable. If any of the direct take amounts specified in this opinion's effects analysis section (2.5) are exceeded, reinitiation of formal consultation will be required because the regulatory reinitiation triggers set out in (2) and/or (3) will have been met.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA , EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)].

This analysis is based, in part, on the descriptions of EFH for Pacific Coast Salmon (PFMC 2016) contained in the fishery management plan developed by the Pacific Fisheries Management Council (PFMC) and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

Essential Fish Habitat is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802[10]). "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (50 CFR 600.10). The term "adverse effect" means any impacts which reduce the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrates and loss of, or injury to, benthic organisms, prey species, and their habitats, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of it and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.910). The EFH consultation mandate applies to all species managed under a Fishery Management Plan (FMP) that may be present in the action area.

3.2. Adverse Effects on Essential Fish Habitat

The Pacific Coast Salmon FMP contains EFH that will be adversely affected by the Project. Both Chinook salmon and coho salmon are expected to occur seasonally within the action area and be exposed to the resistance board weir located in the South Fork Eel River. The resistance board weir will cause brief migratory impediments for salmonids migrating upstream or downstream (see Effects of the Action section). The objectives of the Project are to enhance survival of salmonids by reducing the amount of predation and competition being imposed by non-native Sacramento pikeminnow. NMFS has no conservation recommendations to suggest.

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the researchers and NMFS. Other interested users could include the Army Corps of Engineers, or California Department of Fish and Wildlife. Individual copies of this opinion were provided to the Corps. The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere to conventional standards for style.

4.2. Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3. Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR part 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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